

Effectiveness of the Cavus Foot Orthosis

Matteo LoPiccolo, MD,¹ Margaret Chilvers, MD,² Brian Graham, CPed,³ and Arthur Manoli II, MD⁴

This study investigated the use of a custom cavus foot orthosis (CFO) in the treatment of ankle instability and pain associated with the subtle cavus foot, a common pathological foot alignment in the United States population. Patients referred by a single orthopedic foot and ankle surgeon to a single pedorthotist for a CFO over a 2-year period were eligible. Pain score pre-and postorthosis and number of instability events pre- and postorthosis were retrospectively evaluated. Ninety-three of 174 eligible patients participated. Average age was 48 years (range, 20–75) and patients suffered a variety of foot pathologies. Average pre-CFO pain score was 7.22 (0 no pain, 10 worst pain). Post-CFO pain score average was 2.41 ($p < .0005$). Ninety-two percent of patients reporting ankle instability as a problem experienced a decrease in the frequency of instability events post-CFO. The custom cavus foot orthosis is effective at relieving pain and reducing ankle instability in the patient with the subtle cavus foot alignment. (Journal of Surgical Orthopaedic Advances 19(3):166–169, 2010)

Key words: ankle instability, cavus, orthotic, peroneal tendons, stress fracture

The subtle cavus foot (SCF) has recently been recognized as a cause of a variety of foot complaints (1). The SCF is a common finding in patients presenting with ankle instability, peroneal tendinopathy, lateral foot overload, plantar fasciitis, and metatarsalgia. SCF alignment (Fig. 1) can be caused by a plantarflexed first ray (forefoot driven) or from a primary varus position of the hindfoot (hindfoot driven). To determine the difference, the Coleman block is utilized (2). If the varus position is forefoot driven and is flexible, an orthosis can be utilized to accommodate the position of the first ray. The purpose of this study was to evaluate the effectiveness of a custom cavus foot orthosis (CFO) (Figs. 2 and 3) in alleviating pain and ankle instability due to the above mentioned disorders.

From ¹University of Rochester School of Medicine and Dentistry, Rochester, NY, and Oakwood Hospital, Dearborn, MI; ²Michigan International Foot and Ankle Center, Pontiac, MI; ³Orion Township, MI; ⁴Michigan International Foot and Ankle Center, Pontiac, MI. Address correspondence to: Margaret Chilvers, MD, Michigan International Foot and Ankle Center, 44555 Woodward Avenue, Suite 105, Pontiac, MI 48341; e-mail: pegchilvers@hotmail.com.

Presented at the Annual Meeting of the Michigan Orthopaedic Society, Mackinac Island, MI, June 2006.

Matteo LoPiccolo, MD, received a medical student summer research stipend from the University of Rochester School of Medicine and Dentistry to support his work on this study. Arthur Manoli II, MD, and Brian Graham, CPed, have a financial relationship with DJO, Inc., and receive royalties for the ArchRival (R), an off-the-shelf cavus foot orthotic.

Received for publication June 18, 2009; accepted for publication August 30, 2009.

For information on prices and availability of reprints call 410-494-4994 X232.

1548-825X/10/1903-0166\$22.00/0



FIGURE 1 (A) Subtle cavus foot alignment with visible heel on medial portion of foot when viewed from the front (peek-a-boo heel), present on both the patient's right and left foot. (B) SCF alignment in a different patient (right foot) as viewed from behind. Notice the heel is tipped into a varus position (top portion of heel angled laterally). Left foot is in normal position.

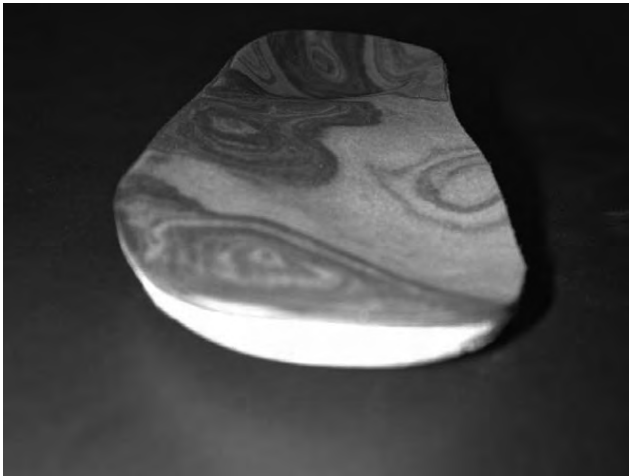


FIGURE 2 Picture of cavus foot orthotic.

Methods

A retrospective study was performed based on patients from the practice of one surgeon specializing in the foot and ankle. The diagnosis of a SCF was made by the senior author and was based on visualization of the “peek-a-boo” heel or fold under the first metatarsal head (1). During a 2-year period, all patients with an SCF and a plantarflexed first ray were fitted with a CFO. The custom orthosis was made by one pedorthist and the same design was used for all patients. Patients were fitted in the semi-standing position and utilizing a 3D foot digitizer with the ability to modify amount and position of support (Amfit, Vancouver, WA). The design includes a full-length orthotic made of ethyl vinyl acetate (EVA) with a hollowing under the first metatarsal head, a ramp at the lateral forefoot, a lowered arch, and a heel cushion. All patients evaluated had one of the following diagnoses: ankle instability, peroneal tendinopathy, lateral foot overload, ankle arthrosis, plantar fasciitis, Achilles tendinosis, or metatarsalgia. These patients were sent a letter from the physician prescribing the CFO explaining that they may be called and asked to participate in the study, which required participating in a questionnaire by phone. They were given 1 month to write or call the above mentioned physician and request not to be called and asked to participate. Patients who were willing to participate received and agreed to informed consent by phone and were questioned on pre- and post-CFO pain complaints. Questioning occurred between 1 and 2 years after beginning treatment with the CFO. Pain complaints were quantified by using a 0–10 pain scale, with 0 representing no pain and 10 being the greatest amount of pain possible. In patients with complaints of ankle instability, the number of instability events pre- and post-CFO were also measured. Based on these results, a Student *t*-test assuming paired samples was

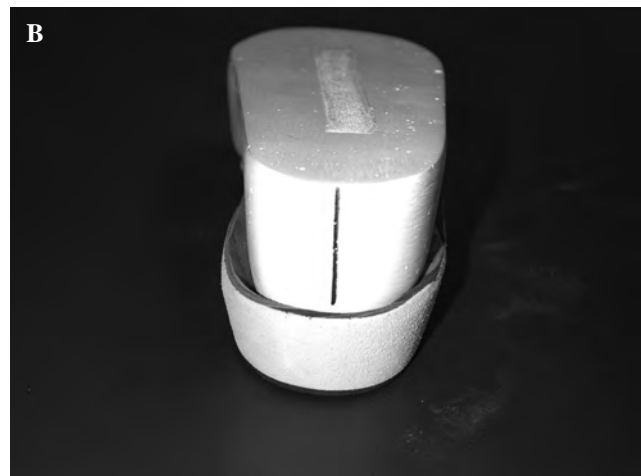
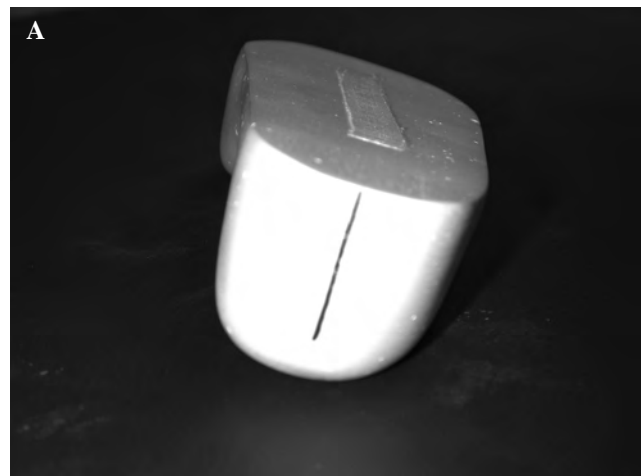


FIGURE 3 (A) Model of the SCF deformity with the heel in varus position. (B) Correction achieved with CFO viewed from behind. Note the heel is no longer in varus position (line drawn on heel is perpendicular to the ground). (C) Correction achieved with CFO as viewed from the side. Note the recess for the plantarflexed first metatarsal and high arch that is allowed by the CFO.

TABLE 1 Subject information

Total number	93
Women	50 (51%)
Men	48 (49%)
Age (years)	48.8 ± 12.6
Time having worn the CFO (months)	18.1 ± 10.9

Values in Table 1 are means ± SD.

used to determine significance for pain scores. *P*-values were corrected for performing multiple *t*-tests. A value of two points of improvement in the visual analog scale (VAS) pre- and post-CFO was determined to be a significant improvement. Methods received approval from the University of Rochester School of Medicine and Dentistry Institutional Review Board.

Results

There were 174 patients referred for the CFO with the included diagnosis. Of those patients, 93 were reached via telephone and agreed to complete the questionnaire. Participant age range was 20 to 75 years with a mean of 48 years. Additional subject demographics are listed in Table 1. There were 82 patients with complaints related to pain, 25 patients with complaints related to instability, and 14 patients with complaints related to both pain and instability. Twenty-three of the 25 (92%) patients complaining of instability reported an improvement in their stability with decreased or zero episodes of “rolling the ankle” with CFO usage.

The results of pain scores are summarized in Table 2. There were nine patients with complaints related to peroneal tendinopathy; eight of those nine patients reported pain score improvement of at least two points. Pre-CFO pain scores averaged 6.0 and post-CFO pain scores were 2.44. Lateral foot overload was the primary complaint in 15 patients, and all 15 obtained pain improvement of a minimum of two points after wearing the CFO. Pre-CFO score was 6.93 and post-CFO average was 2.0. In 17 patients the primary complaint was metatarsalgia, including sesamoiditis. Pain scores for all 17 patients improved by at least two points with the CFO. Average

pre-CFO pain score was 7.88 and post-CFO score was 2.41. Ankle arthrosis was the complaint in 11 patients and all improved by at least two points. Average pre-CFO pain score was 6.45 and post-CFO pain score was 1.64. There were 30 patients with complaints related to plantar fasciitis or Achilles tendinosis and 29 were improved by at least two points. Pre-CFO average pain score was 7.53 and post-CFO average was 2.17. All categories were statistically significant.

In addition, these data were recalculated using an improvement of four points on the VAS to determine a significant improvement. Utilizing this stricter criterion, 75.9% of the total patients had an improvement in pain of at least four points.

Discussion

The presence of the cavus foot position in humans has long been recognized. Typically it has been associated with Charcot-Marie-Tooth disease, polio, scarred muscle, or a residual clubfoot. With physical exam techniques that are easier to recognize, such as the “peek-a-boo” heel, the subtle cavus foot has been noted in higher numbers (3). In a report by Ledoux et al., a study of 2047 diabetic feet revealed a cavus foot alignment in 24.1% (4). In a single podorthotist practice, there were 54% of patients referred for the cavus foot orthotic (5).

When treating patients with a subtle cavus foot alignment, treatment is dictated by the underlying cause of the cavus (i.e., forefoot or hindfoot driven). In patients with a flexible, forefoot-driven cavus foot, treatment can be initiated by incorporating a custom orthosis. Bordelon has reviewed orthotics in great detail and has reported that full-length custom orthotics can be used to place a foot that is biomechanically malpositioned into a corrected position by posting correctly (6). The orthotic utilized in this study was a custom, full-length orthotic made of EVA, incorporating a hollowing under the base of the first metatarsal head and a lateral wedge under the forefoot. The arch height was lowered to allow the foot to evert.

Burns et al. looked at the use of a custom orthosis for their patients with cavus foot alignment (7). Their

TABLE 2 Pain score results (visual analog scale)

Secondary Diagnosis Category	N	Pain Score Before CFO	Pain Score After CFO	Difference	Patients With Pain Decrease ≥ 2 Points
Peroneal tendinopathy	9	6.00 ± 1.80	2.44 ± 3.05	-3.56 (<i>p</i> < .001)	8 (88.9%)
Lateral foot overload	15	6.93 ± 1.44	2.00 ± 2.48	-4.93 (<i>p</i> < .0005)	15 (100%)
Metatarsalgia	17	7.88 ± 1.22	2.41 ± 1.87	-5.47 (<i>p</i> < .0005)	17 (100%)
Ankle arthrosis	11	6.45 ± 1.65	1.64 ± 1.91	-4.81 (<i>p</i> < .0005)	11 (100%)
Plantar fasciitis/Achilles tendinopathy/other	31	7.53 ± 1.63	2.17 ± 2.48	-5.36 (<i>p</i> < .0005)	29 (93.5%)
Overall	83	7.22 ± 1.71	2.41 ± 2.62	-4.81 (<i>p</i> < .0005)	80 (96.4%)

Values in Table 2 are means ± SD.

population included idiopathic and neuromuscular cavus patients. The orthotic design incorporated a flexible shell contoured to the nonweightbearing foot with cushioned top to better distribute pressure. They found a moderate effect of the custom orthosis on foot pain compared to the control. No attempts were made in their study to realign the foot to promote a more biomechanical neutral position. No other studies could be identified to evaluate custom orthosis in the subtle cavus patient.

Limitations to this study include the retrospective nature of the study and reliance on patient recall to determine preorthotic pain and instability. Some patients also had multiple complaints before the use of the orthotic, while only the relief in the major complaint was examined. This also contributes to less reliable recall in patients. Overall, the majority of patients were very satisfied with the CFO and required no further treatment.

References

1. Manoli, A., II, Graham, B. The subtle cavus foot, "the underpronator," a review. *Foot Ankle Int.* 26:256–263, 2005.
2. Coleman, S. S., Chesnut, W. J. A simple test for hindfoot flexibility in the cavovarus foot. *Clin. Orthop.* 123:60–62, 1977.
3. Beals, T. C., Manoli, A., II. The peek-a-boo heel sign in the evaluation of hindfoot varus. *Foot* 6:205–206, 1996.
4. Ledoux, W. R., Shofer, J. B., Ahroni, J. H., et al. Biomechanical differences among pes cavus, neutrally aligned, and pes planus feet in subjects with diabetes. *Foot Ankle Int.* 24:845–850, 2003.
5. Manoli, A., II, Graham, B. G. Foot morphology in a pedorthic practice. Presented at the Annual Meeting of the Michigan Orthopaedic Society, Mackinac Island, MI, June 19, 2004.
6. Bordelon, R. L. Practical guide to foot orthoses. *J. Musculoskel. Med.* 6:71–87, 1989.
7. Burns, J., Crosbie, J., Ouvrier, R., et al. Effective orthotic therapy for the painful cavus foot, a randomized controlled trial. *JAPMA* 96:205–211, 2006.